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University of California
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Berkeley, California

Statistical Analysis of the Annual Farm Prices for Seasonal Types of Commercial Head Lettuce, 1918-1947

by

Sidney Hoos

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In February 1948, the California Agricultural Experiment Station issued the following two publications on commercial head lettuce:

"Commercial Head Lettuce, Economic Status 1947," (Calif. Agr. Exp. Sta. Circ. 378, February 1948); and

"Statistical Supplement to Agricultural Experiment Station Circular 378," (February 1948), Processed

The circular reviewed and analyzed historical trends in the commercial head lettuce industry and summarized its current economic status. The statistical supplement to the circular presented the detailed data on the industry.

This report may be viewed as a continuation of the work reflected in the two previous publications on commercial head lettuce. In particular, the purpose of this report is to present the results of an analysis of the major factors which have influenced and are correlated with the prices and shipments of commercial head lettuce from 1918 through 1947.

As oranges and lemons are considered to be segregated according to "summer" and "winter," depending on the time of picking and shipping, commercial head lettuce is separated into seasonal periods. The annual lettuce season is divided into the following marketing periods: winter; early-spring; late-spring; summer; and fall. Although there actually is no clear-cut separation of these seasonal types of lettuce, for purposes of convenience as well as reflecting to a great extent production and marketing practices, the following classification has been established:

Winter:	acreage planted after September 1 for harvest during December 15-March 15.
Spring:	in general, acreage planted prior to March 1 for harvest until July 1.
Early-Spring:	planted during January for harvest to May 1.
Late-Spring:	planted during February for harvest to July 1.
Summer:	acreage planted during the period March 1-June 1 for harvest during July 1-September 1.
Fall:	acreage planted between June 1 and September 1 for harvest after September 1.

1/ Associate Professor of Agricultural Economics, Associate Economist in the Experiment Station and on the Giannini Foundation.

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In the analyses underlying this report, early-spring and late-spring lettuce are combined. Hence, the resulting four seasonal types are considered to be marketed during the following months:

Seasonal Type	Marketing Period
"Winter"	January -March
"Spring"	April -June
"Summer"	July -August
"Fall"	September-December

"All types combined," therefore, cover the twelve-month period from January through December.

In the statistical analysis presented in this report, the results for the respective seasonal types pertain to the corresponding marketing periods noted in the preceding paragraph. Although California is the dominant commercial lettuce producing state, this report concerns itself with the national situation. California growers and shippers of commercial lettuce face competition from growers and shippers in other parts of the country during all four of the seasonal marketing periods.

The basic data used in the analyses are given in tables 1, 2, and 3. With respect to the basic data, the following comments are pertinent. For the supply series, the most appropriate data would be total commercial shipments; however, an adequate series of that nature is not available. Therefore, we have used harvested production of commercial lettuce, which is highly correlated with the quantities taken by the market. For the income variable, unrevised data were used in the analyses summarized in table 4 and the revised income series were used in the analyses summarized in table 5. The two series differ effectively only in the last several years. Table 3 shows the revised income series.

In some of the regression analyses, "time" was introduced as one of the independent variables. In those cases, "time" is used as a proxy for and is presumed to exhibit the combined influence of factors which change slowly and smoothly with time. In commercial head lettuce, such factors probably include tastes and attitudes of consumers affected by changing ideas of nutrition and changing relative importance of the several seasonal types of lettuce. These may be combined under the factor of "shifts in the demand" for commercial head lettuce, reflected by the "time" variable.

Table 4 presents the multiple regression results for the period 1918-1946. For each of the seasonal types, as well as for all types combined, price and quantity, respectively, are considered as functions of the indicated independent variables. Hence, two formulations of statistical demand characteristics are given for each of the seasonal types and for all types combined, respectively. All of the empirical demand formulations are not equally acceptable on statistical grounds, as may be noted by examination of the various coefficients of multiple correlation and the t-ratios of the net regression coefficients. In all cases the signs of the net regression coefficients are consistent with what would be expected from the viewpoints of economic theory and marketing experience.

As an example of the usual interpretation of the statistical demand results, we can consider equation No. 1 of table 4, which expresses the <u>average</u> net relations between the supply of commercial lettuce taken by the United States market

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during January-December (1) the United States farm price, (2) nonagricultural income level in the United States, and (3) the "time" trend. Expressed in numerical terms, these relations are as follows: (a) with both the nonagricultural income and the "time" trend held constant, a change of $1.00 per crate in the United States farm price for commercial head lettuce was, on the average, accompanied by a change in the opposite direction of 5 million crates of commercial head lettuce taken by the United States market; (b) with both the price and the "time" trend held constant, a change of 10 points in the income index was, on the average, accompanied by a change in the same direction of 800,000 crates of commercial lettuce taken by the United States market; and (c) with both the price and income held constant, a change of one time unit in the "time" trend was, on the average, accompanied by a change in the same direction of 600,000 crates of commercial lettuce taken by the United States market. The combined influence of price, income, and the "time" trend variables statistically accounts for about 93 per cent of the observed year-to-year variation in the quantity of commercial head lettuce taken by the United States market. These results are average relations for the period under consideration, 1918-1946.

The other equations in table 4 (equations 2 through 10) are interpreted in the same manner as for equation 1 considered in the preceding paragraph, with attention given to the respective dependent and independent variables.

Differences between the actual values of the dependent variable and those estimated by equation 1 are plotted as deviations from the net regression lines in figure 1. Also, the differences between the actual values of the dependent variable and those estimated by equation 2 are plotted as deviations from the net regression lines in figure 2. Similar net regression charts were constructed for the other equations in the course of the study in order to discern hints as to whether other formulations of the demand characteristics would yield improved statistical fits.

It is noted that the statistical results presented in table 4, and briefly discussed in the preceding paragraphs, are based on the period 1918-1946 which includes the war years during which there was federal price control on commercial head lettuce. Hence, statistical demand formulations were studied for the period 1918-1947, but excluding the war years 1942-1945. These results are summarized in table 5. It is of some interest that, in general, the results of the two sets of analyses agree reasonably well. But such correspondence may be expected; 25 of the same years in the 30-year period from 1918 through 1947 were used in both sets of analyses.

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TABLE 1

United States Commercial Head Lettuce
Harvested Production
(in Millions of Crates)

Year	"Winter" lettuce	"Spring" lettuce	"Summer" lettuce	"Fall" lettuce	Annual (Jan.-Dec.)
1918	1.64	1.25	.61	.29	3.79
1919	1.23	1.69	.66	.75	4.33
1920	3.50	2.22	.91	1.07	7.70
1921	2.54	2.26	1.19	1.22	7.21
1922	3.01	2.42	1.65	2.21	9.29
1923	4.21	2.68	1.83	1.66	10.37
1924	4.92	3.54	1.64	2.32	12.42
1925	4.84	4.41	2.37	2.09	13.70
1926	5.02	4.92	2.37	2.79	15.10
1927	5.16	4.84	3.54	3.44	16.98
1928	5.85	5.55	3.58	3.48	18.46
1929	6.26	4.45	4.90	4.38	19.99
1930	5.74	5.96	4.26	3.86	19.82
1931	5.35	5.76	3.83	4.41	19.34
1932	4.83	5.00	3.67	3.88	17.38
1933	4.49	5.01	3.77	4.02	17.29
1934	3.83	5.96	4.23	4.78	18.81
1935	4.07	6.07	4.44	4.68	19.25
1936	4.45	7.23	4.56	4.37	20.60
1937	4.65	6.51	4.66	4.80	20.63
1938	4.45	5.93	3.96	4.57	18.81
1939	5.19	6.93	4.85	5.00	21.96
1940	4.61	7.07	4.86	4.82	21.36
1941	5.30	7.49	5.40	4.86	23.05
1942	5.73	7.70	5.00	4.99	23.43
1943	5.80	7.37	5.44	5.81	24.42
1944	7.31	8.80	6.14	6.16	28.40
1945	7.55	9.12	6.60	6.45	29.71
1946	8.92	9.43	7.45	7.88	33.69
1947					34.05

Source of data: Detailed sources noted in Statistical Supplement to California Agricultural Experiment Station Circular 378, Commercial Head Lettuce, Economic Status 1947, February 1948.

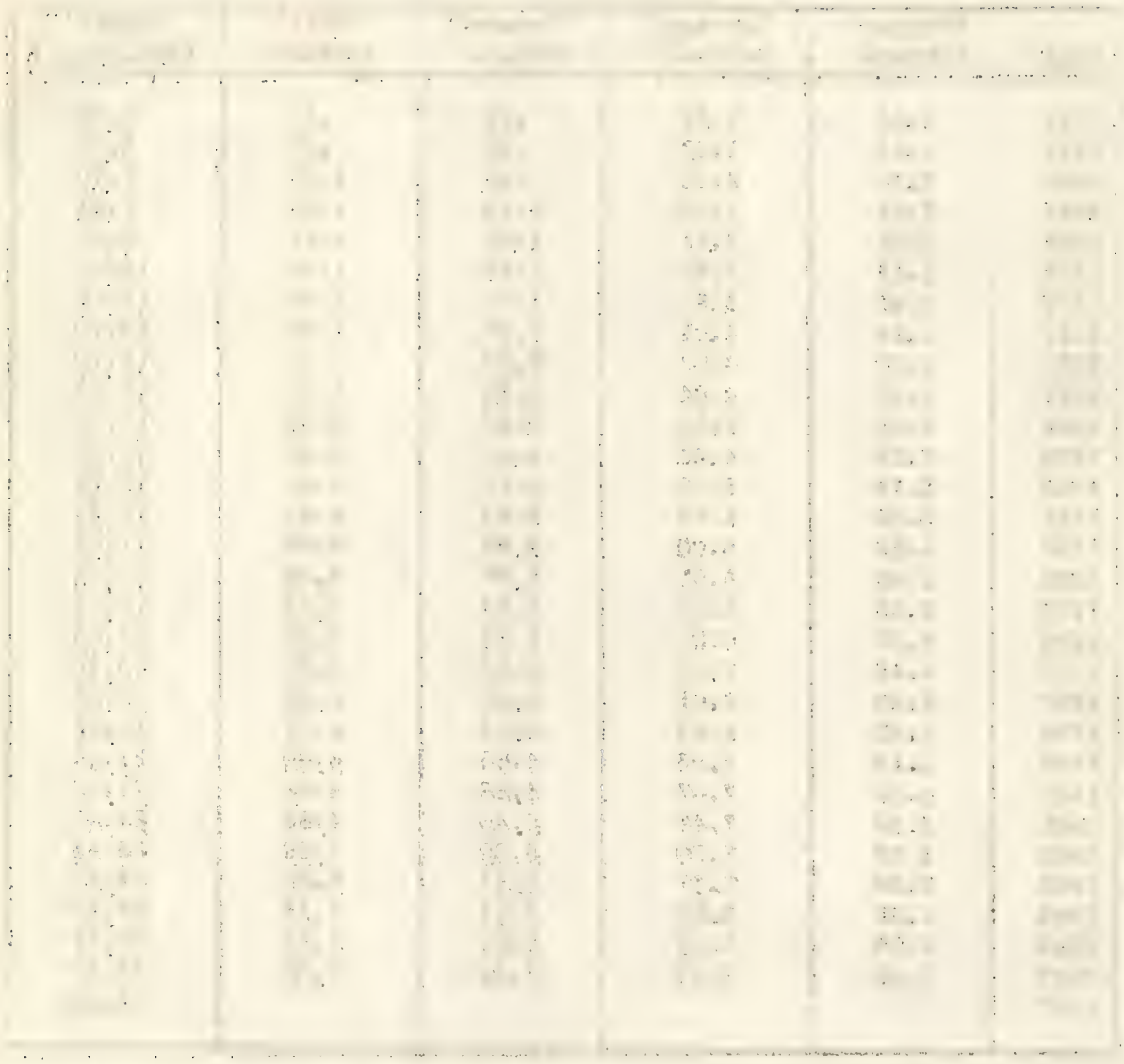


TABLE 2

United States Commercial Head Lettuce
Farm Price
(Dollars per Crate)

Year	"Winter" lettuce	"Spring" lettuce	"Summer" lettuce	"Fall" lettuce	Annual (Jan.-Dec.)
1918	1.21	1.71	2.33	2.20	1.63
1919	1.45	1.94	2.52	2.07	1.91
1920	1.30	1.32	2.51	1.86	1.53
1921	1.48	1.83	3.01	1.77	1.89
1922	1.90	2.17	1.79	1.62	1.88
1923	1.51	1.52	1.87	1.66	1.60
1924	1.53	1.52	1.83	1.54	1.57
1925	1.58	1.23	1.54	1.60	1.46
1926	1.93	1.50	1.63	1.57	1.68
1927	1.34	1.36	1.40	1.27	1.34
1928	1.43	1.52	1.95	2.21	1.70
1929	1.89	2.04	1.69	1.74	1.84
1930	1.87	1.62	1.52	1.85	1.72
1931	1.42	1.17	1.86	1.64	1.48
1932	1.55	1.32	1.00	1.21	1.29
1933	1.26	1.13	1.45	1.41	1.30
1934	1.35	1.66	1.26	1.23	1.40
1935	1.28	1.71	1.21	1.54	1.46
1936	1.10	1.35	1.85	1.57	1.46
1937	2.04	1.76	1.41	1.06	1.58
1938	1.08	1.98	1.35	1.50	1.52
1939	1.47	1.23	1.36	1.51	1.38
1940	1.33	1.83	1.28	1.30	1.48
1941	1.40	1.87	1.78	1.54	1.67
1942	2.19	1.86	3.25	3.27	2.54
1943	3.64	3.84	2.81	2.78	3.31
1944	2.65	2.65	2.38	2.72	2.61
1945	2.73	3.01	3.13	2.85	2.93
1946	2.84	2.58	2.44	2.67	2.64
1947					3.18

Source of data: Detailed sources noted in Statistical Supplement to California Agricultural Experiment Station Circular 378, Commercial Head Lettuce, Economic Status 1947, February 1948.

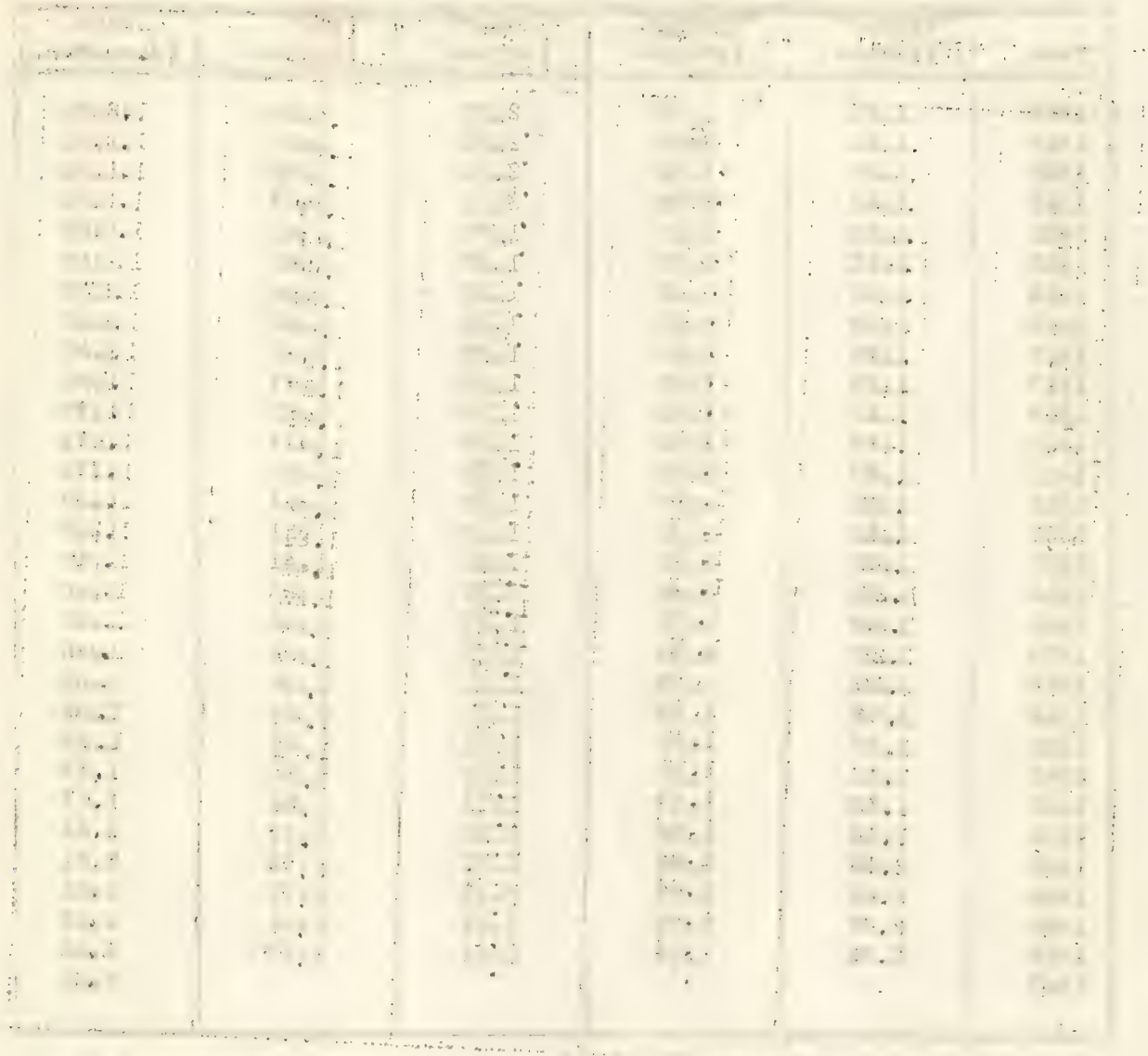


TABLE 3

United States Nonagricultural Income
(1935-1939 = 100)

Year	Winter average Jan.-Feb.-Mar.	Spring average Apr.-May-June	Summer average July-Aug.	Fall average Sept.-Oct. Nov.-Dec.	Annual Jan.-Dec.
1918	68.0	77.0	77.5	75.5	74.7
1919	76.9	76.1	83.2	87.2	81.2
1920	94.5	95.3	96.8	91.4	94.1
1921	84.3	82.9	83.0	82.3	83.1
1922	80.5	83.9	87.4	93.2	86.8
1923	95.1	98.5	100.7	102.3	99.3
1924	104.9	103.4	100.1	102.8	103.1
1925	106.5	107.5	110.4	113.2	109.7
1926	114.7	113.3	113.4	115.6	114.4
1927	116.1	116.6	116.4	115.1	115.9
1928	116.7	117.6	120.4	120.0	118.6
1929	121.3	122.6	123.8	122.8	122.5
1930	117.5	113.6	108.6	103.8	110.4
1931	101.7	99.8	93.2	87.3	94.9
1932	81.3	74.3	69.6	68.5	73.3
1933	66.7	67.1	70.8	74.6	70.1
1934	79.1	80.0	80.5	80.4	80.0
1935	83.9	85.6	86.4	89.2	86.5
1936	93.8	103.2	105.6	103.5	101.4
1937	106.4	109.7	109.6	104.6	107.1
1938	98.9	97.4	98.0	100.6	98.9
1939	103.3	104.1	106.4	109.4	106.0
1940	111.6	112.5	115.0	119.3	115.0
1941	126.9	134.0	142.0	148.0	138.2
1942	156.8	167.5	179.2	191.2	174.6
1943	205.4	212.8	217.9	224.6	215.7
1944	233.8	236.6	240.9	244.8	239.4
1945	251.0	251.6	250.6	242.2	248.1
1946	242.5	248.7	255.6	264.2	253.5
1947	270.8	272.6	277.6	294.8	280.4

Source of data: U.S. Bureau of Agricultural Economics mimeo. dated 4-11-44, National Income Supplement to Survey of Current Business, July 1947, table 48. Survey of Current Business, Dec. 1947.

TABLE 4

United States Commercial Head Lettuce
Regression Coefficients and Auxiliary Constants for
Statistical Regression Analysis Covering 1918-1946

Seasonal type of lettuce	Equation number	Dependent variable	Constant term	Net regression coefficients[a] (figures in parentheses are t-ratios)				Adjusted coefficient of multiple correlation $\bar{R}$
				X_1	X_2	X_3	X_4	
	1	2	3	4	5	6	7	8
All types combined	1	X_1	16.7864		-5.1791 (3.4743)	.0861 (4.4774)	.5987 (9.5376)	.965
	2	X_2	1.3765	-.0629 (3.4743)		.0128 (10.3185)	.0275 (1.9886)	.915
Winter	3	X_1	2.6518		-.5981 (1.1353)	.0275 (3.5143)	.0538 (1.9770)	.840
	4	X_2	.6226	-.0931 (1.4272)		.0132 (5.9638)		.845
Spring	5	X_1	5.4123		-.9670 (4.4209)	.0148 (4.5452)	.2274 (16.3163)	.980
	6	X_2	2.8050	-.4537 (4.4209)		.0123 (7.0085)	.1004 (3.9134)	.857
Summer	7	X_1	3.5611		-.6546 (2.9105)	.0118 (3.0434)	.1561 (8.2716)	.960
	8	X_2	1.2414	-.2753 (4.7373)		.0141 (6.6791)		.777
Fall	9	X_1	3.8730		-.5426 (1.6785)	.0078 (1.6421)	.1826 (9.6197)	.955
	10	X_2	.9037	-.1450 (3.2219)		.0121 (7.5211)		.830

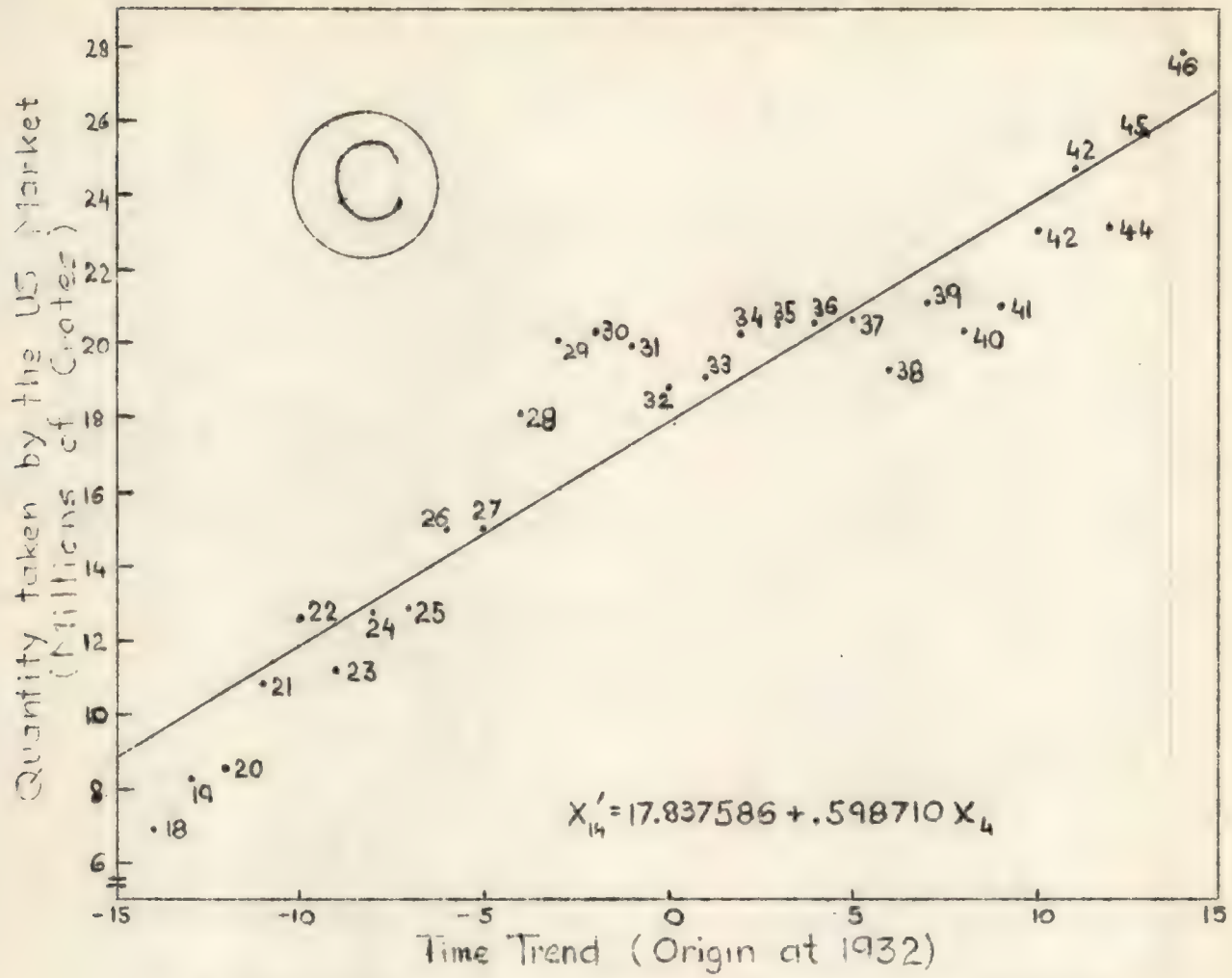
a/ X_1=United States harvested production of lettuce in units of millions of crates.
X_2=United States farm price of lettuce in dollars per crate.
X_3=Index of United States nonagricultural incomes, 1935-1939=100.
X_4=Time in years, origin at 1932.

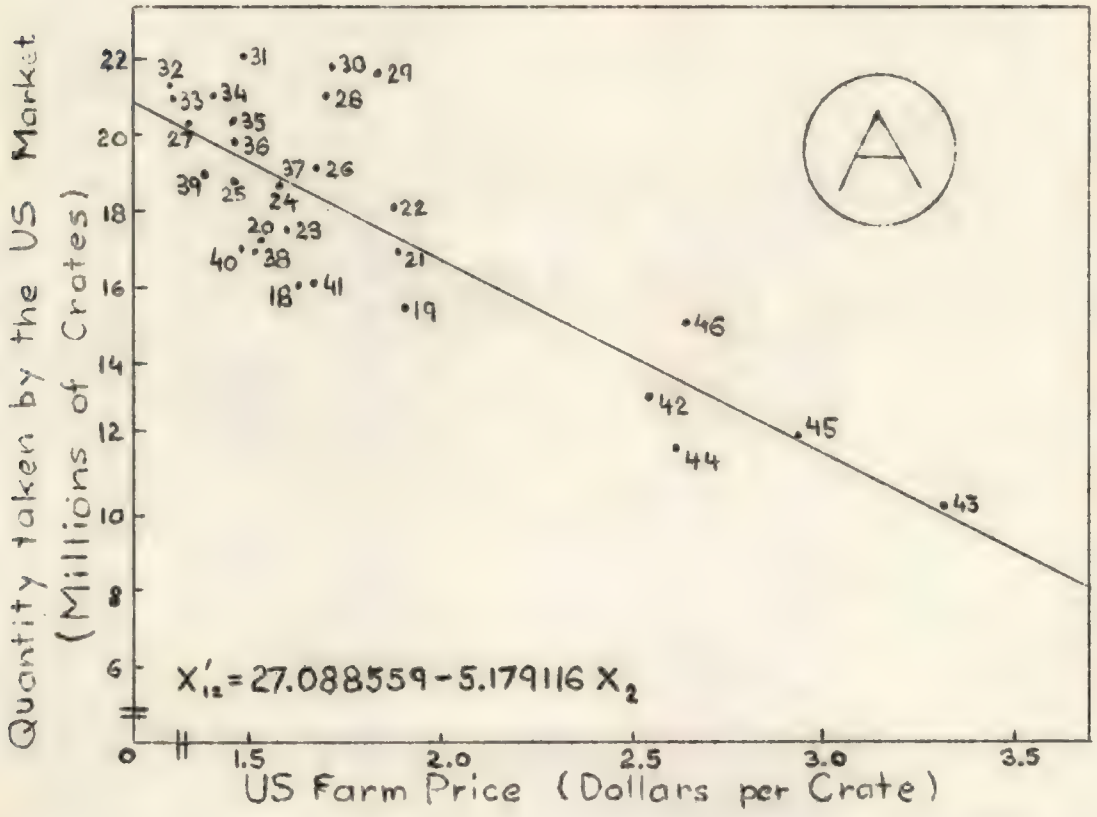
Winter lettuce is marketed during January-March; Spring lettuce during April-June; Summer lettuce during July - August; and Fall lettuce during September-December.

The quantity and price series for the different seasonal types reflect transactions during the respective months in the season.

The income index for the different seasonal types is the average of the monthly values for the respective months in the season.

Figure 1. United States Lettuce--Quantity Taken by the Market Related to: (A) Seasonal Farm Prices, (B) Index of United States Nonagricultural Income, and (c) Time Trend (Based on Equation 1, Table 4)





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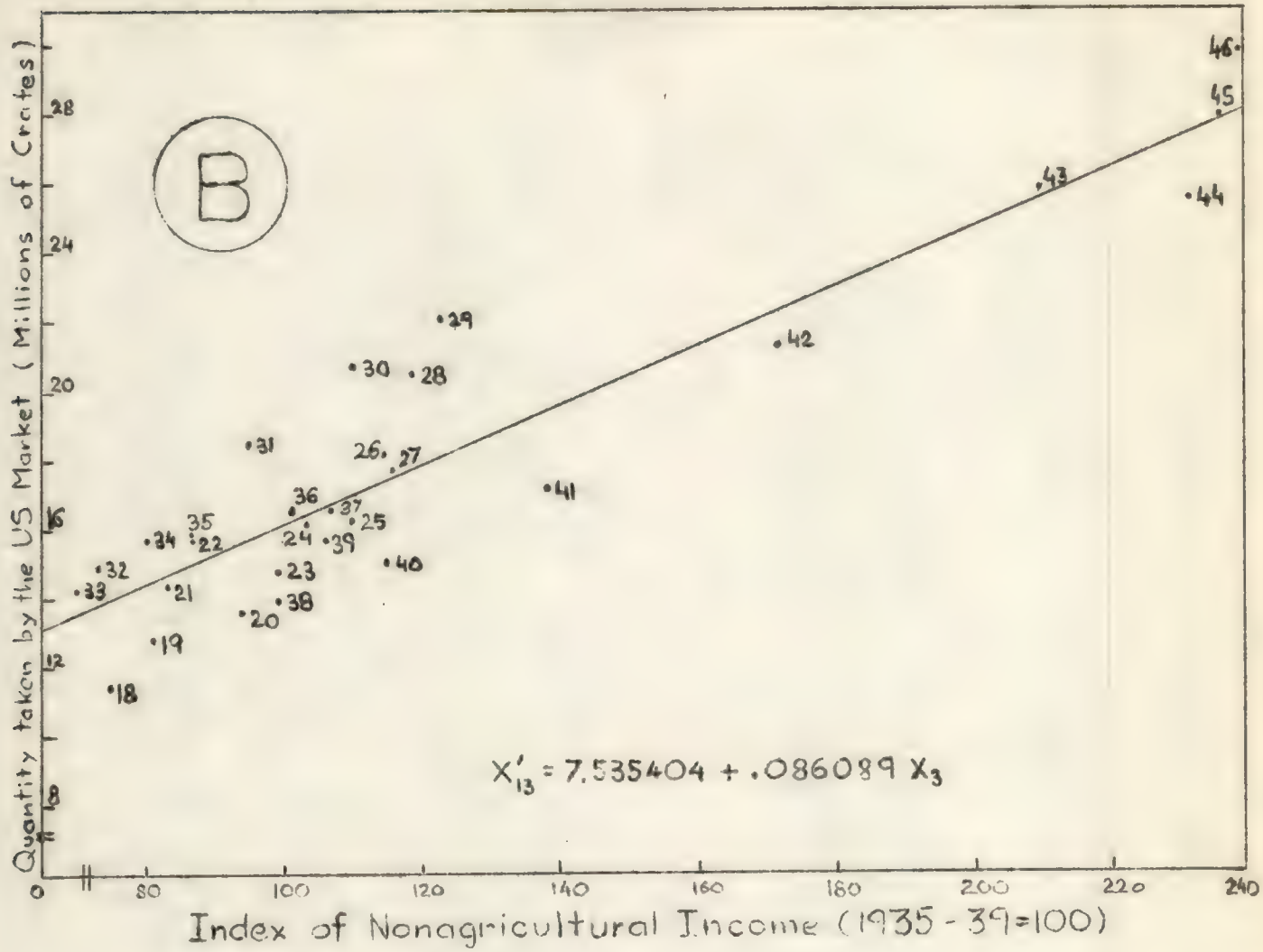


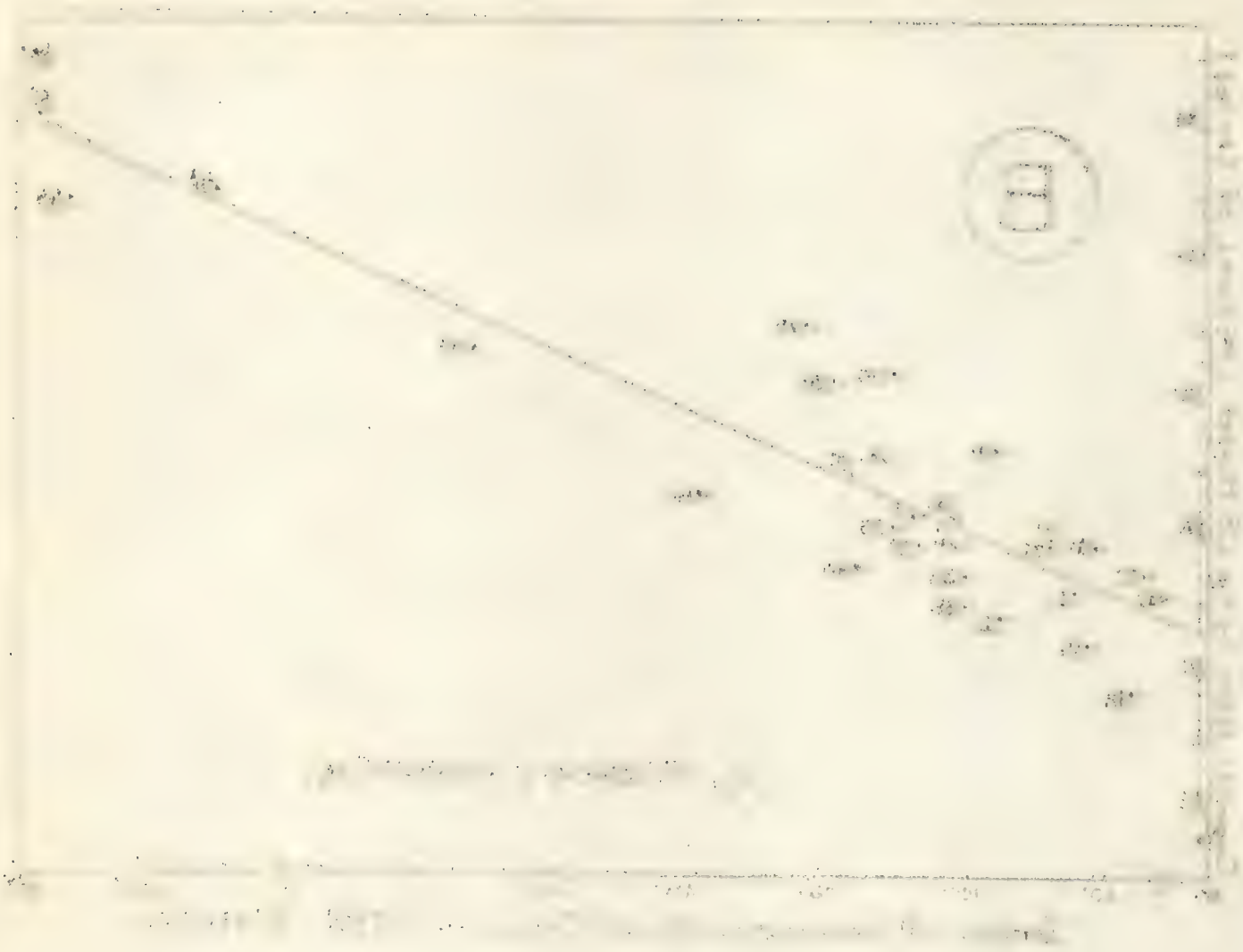
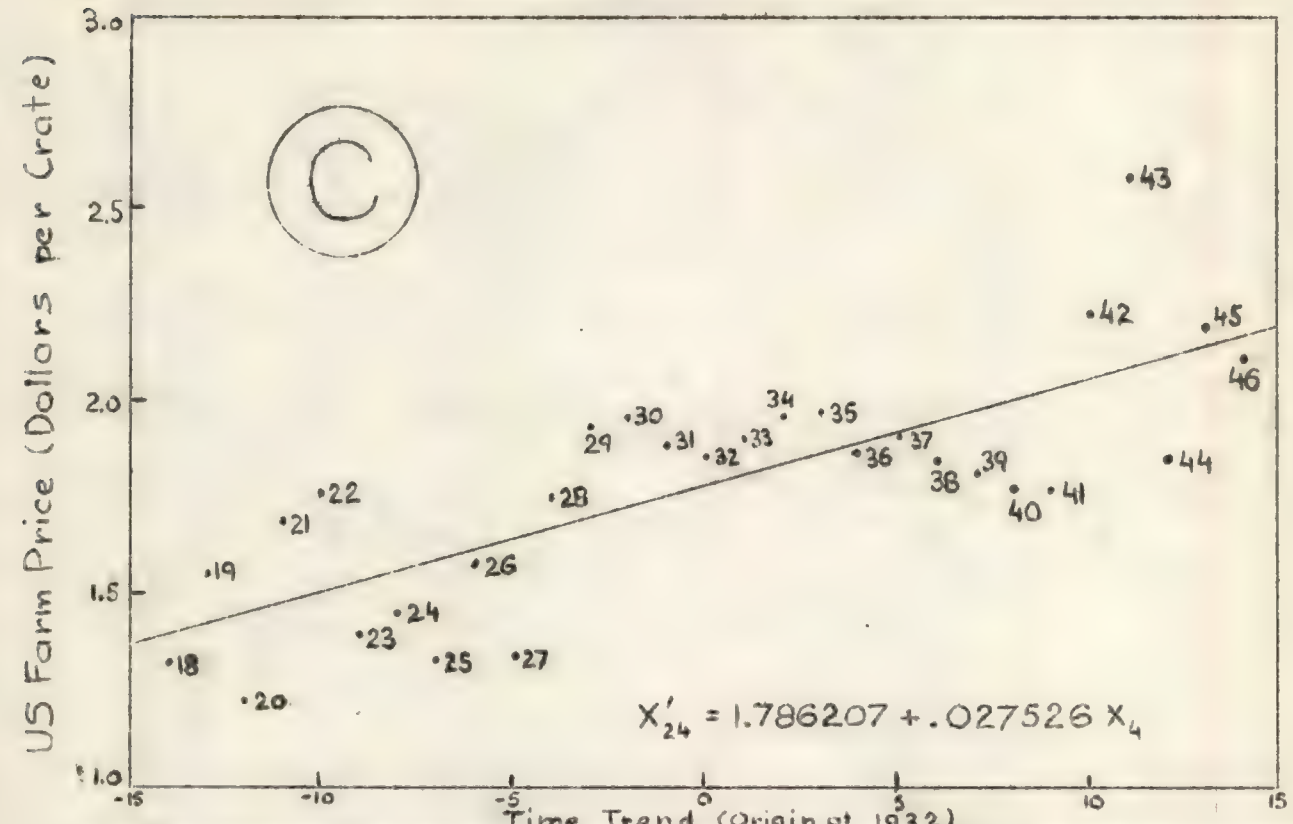
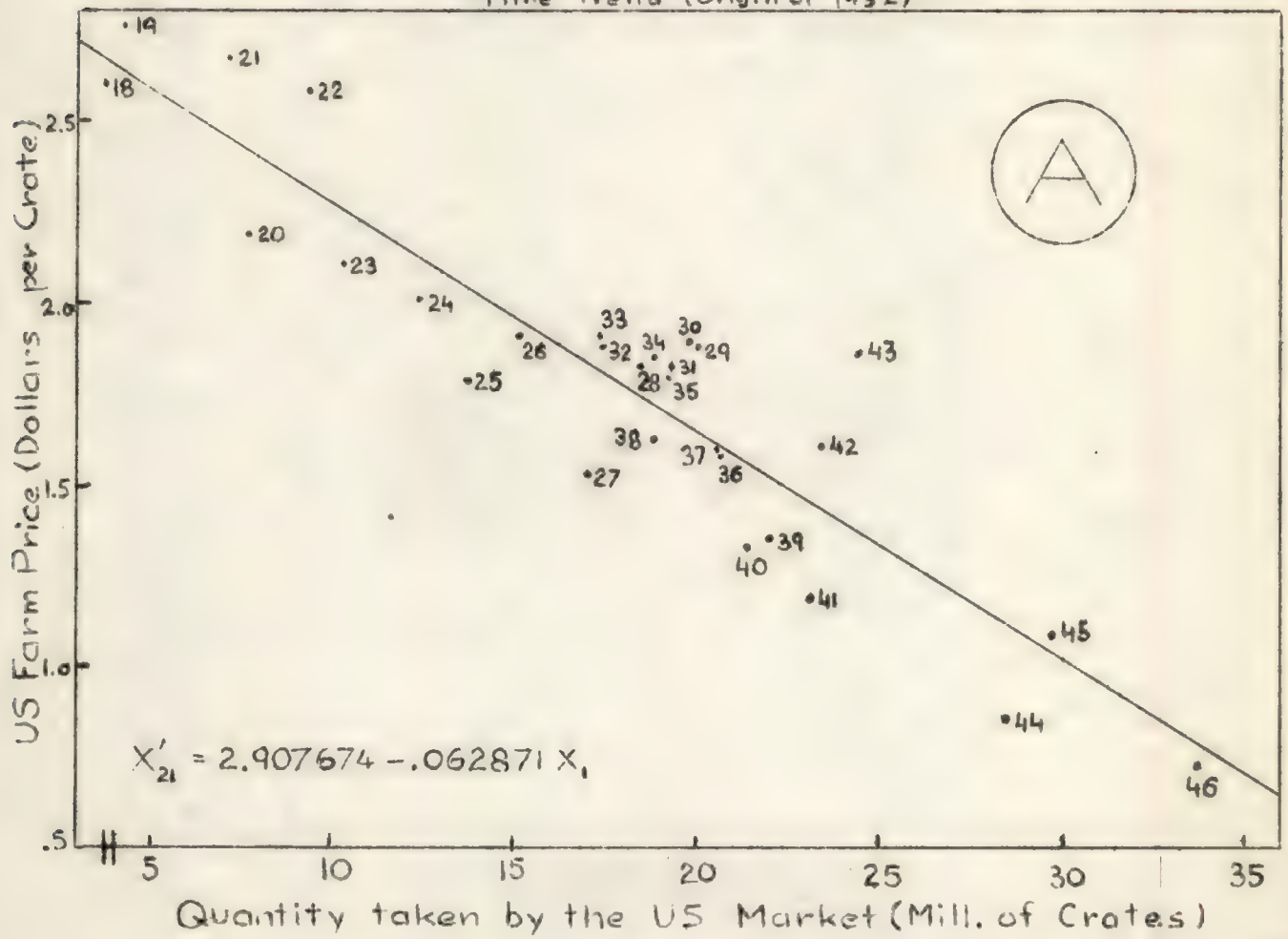


Figure 2. United States Lettuce--Seasonal Farm Prices Related to (A) Quantity Taken by the Market, (B) Index of United States Nonagricultural Income, and (C) Time Trend (Based on Equation 2, Table 4)





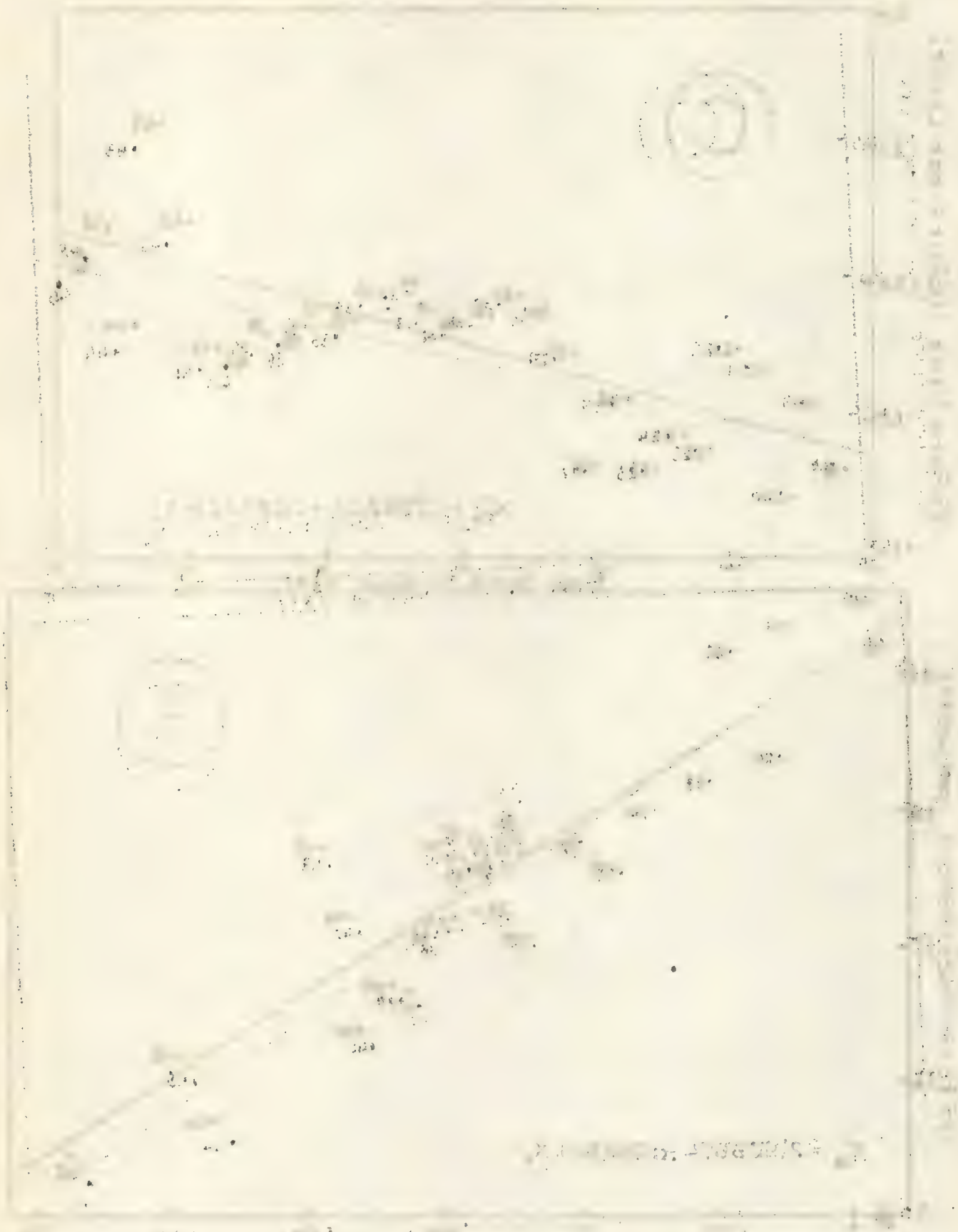
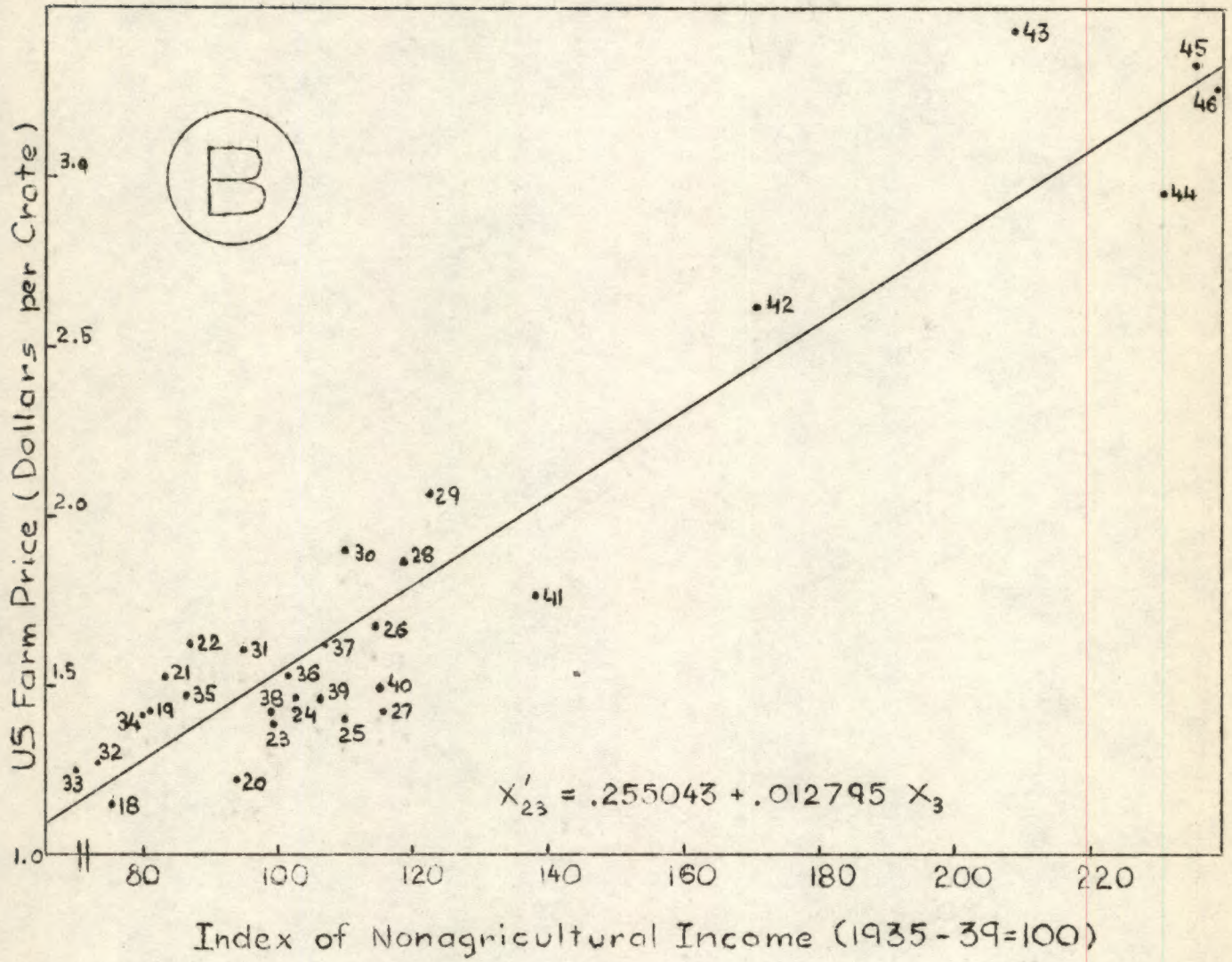


Figure 2 (Continued)



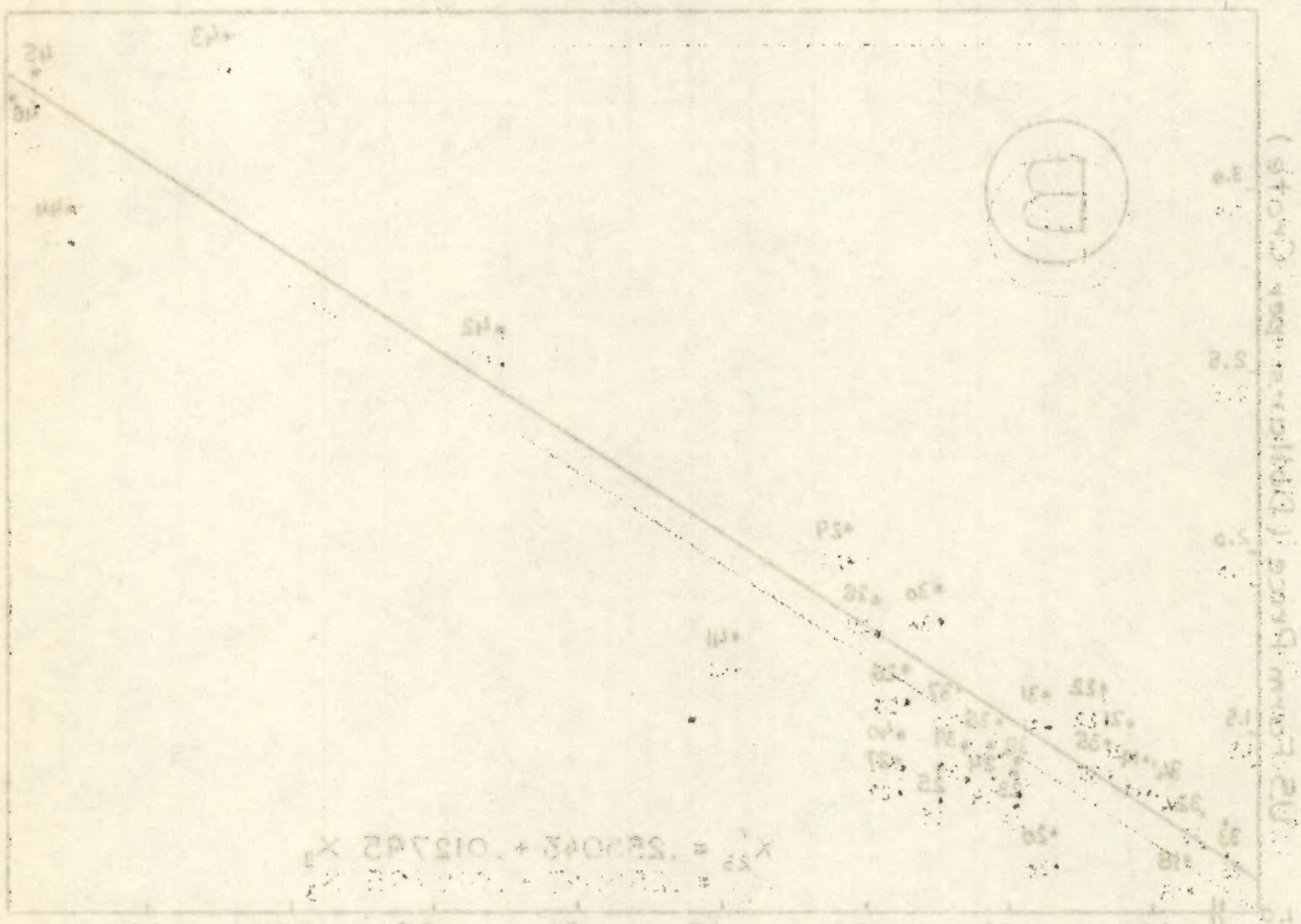


TABLE 5

United States Commercial Head Lettuce
Regression Coefficients and Auxiliary Constants for
Statistical Regression Analysis Covering 1918-1947 Excluding 1942-1945

Seasonal type of lettuce	Equation number	Dependent variable	Constant term	Net regression coefficients[a] (figures in parentheses are t-ratios)				Adjusted coefficient of multiple correlation $\bar{R}$
				X_1	X_2	X_3	X_4	
	1	2	3	4	5	6	7	8
All types combined	1	X_1	16.0876		-4.5544 (2.0455)	.0838 (3.6821)	.6109 (8.5391)	.966
	2	X_2	.9699	-.0269 (3.9237)		.0104 (9.9736)		.915
Winter	3	X_1	2.1723		- .0662 (.0092)	.0248 (2,7433)	.0630 (2.2641)	.866
	4	X_2	.6308	-.0446 (.7814)		.0108 (5.1614)		.860
Spring	5	X_1	5.3349		-1.0034 (3.3401)	.0164 (4.6756)	.2298 (15.6960)	.978
	6	X_2	2.3151	-.3354 (3.3401)		.0109 (6.4376)	.0738 (2.9463)	.821
Summer	7	X_1	3.2350		- .5392 (1.9649)	.0134 (3.2574)	.1619 (7.6444)	.963
	8	X_2	1.2827	-.2739 (5.1357)		.0134 (6.5256)		.789
Fall	9	X_1	3.6756		- .2140 (.4754)	.0048 (1.0921)	.1926 (9.1557)	.958
	10	X_2	1.2599	-.1369 (3.8336)		.0080 (6.4745)		.785

a/ X_1=United States harvested production of lettuce in units of millions of crates.
X_2=United States farm price of lettuce in dollars per crate.
X_3=Index of United States nonagricultural income, 1935-1939=100.
X_4=Time in years, origin at 1932.

Winter lettuce is marketed during January-March; Spring lettuce during April-June; Summer lettuce during July-August; and Fall lettuce during September-December.

The quantity and price series for the different seasonal types reflect transactions during the respective months of the season.

The income index for the different seasonal types is the average of the monthly values for the respective months in the season.

TABLE 6

United States Commercial Head Lettuce

Regression Coefficients and Auxiliary Constants for

Statistical Regression Analysis Covering 1918-1947 Excluding 1942-1945

Seasonal Type of Lettuce	Equation Number	Dependent Variable	Constant term	Net regression coefficients (figures in parentheses are t-tests)				Adjusted coefficient of multiple correlation
				X_1	X_2	X_3	X_4	R
	1	2	3	4	5	6	7	8
All types combined	1	X_1	-16.0876		-.4.8544 (2.0466)	.0656 (3.6821)	.6109 (8.3391)	.986
	2	X_2	.9639	-.0869 (3.8457)		.0104 (8.8726)		.915
Winter	3	X_1	-2.1728		-.0852 (.6892)	.0248 (3.7855)	.0850 (4.3641)	.886
	4	X_2	.8508	-.0446 (1.7914)		.0108 (2.7614)		.860
Spring	5	X_1	5.6519		-3.1001 (3.3401)	.0164 (4.6755)	.2208 (15.6660)	.979
	6	X_2	3.3151	-.5884 (3.9801)		.0109 (6.4870)	.0738 (23.1603)	.921
Summer	7	X_1	3.2350		-.6885 (4.6449)	.0164 (8.3674)	.1619 (29.5441)	.965
	8	X_2	1.1827	-.2439 (3.3257)		.0134 (6.6566)		.789
Fall	9	X_1	3.8476		-.5140 (4.9581)	.0218 (11.0547)	.1938 (40.4807)	.969
	10	X_2	1.1599	-.1859 (3.8358)		.0090 (8.4746)		.768

X_1=United States harvested production for Junuie (in units of millions and crates.

X_2=United States farm price of Lettuce (in dollars per crate.

X_3=Index of United States consumers' income (1935-39=100.

X_4=Time in years, origin in 1932.

Winter lettuce is marketed during September-October through March-April; Spring lettuce during April-August; and Fall, during September-December.

The quantity used proxy between the different seasonal types is the natural logarithm of the net.

of the season.

The decade index for the different seasonal types is the average of the monthly values for the particular months in the season.